APPENDIX A

MODEL TRAINING PROGRAM

The following guidance may be used to develop a training program. If you use the frequency and subject listings to develop your training program, you may state on your application, "We will establish and implement the model training program that was published in Appendix A to Regulatory Guide 7.0, and is attached as Item 8, that identifies the groups of workers who will receive training and the method and frequency of training." You may use lectures, video-taped presentations, or demonstrations, for example, as methods of training.

If you prefer, you may develop your own training program for review. If you do so, you should consider for inclusion all the features in the model program and carefully review the requirements of 180 NAC 1-010.03. Say on your application, "We have developed a training program for your review that is attached as Item 8." Be sure to include the table that identifies groups of workers, the method of their training, and the frequency of training.

It may not be assumed that safety instruction has been adequately covered by prior occupational training, board certification, etc. Site-specific training should be provided for all workers. Ancillary personnel (e.g., nursing, clerical, housekeeping, security) whose duties may require them to work in the vicinity of radioactive material (whether escorted or not) need to be informed about radiation hazards and appropriate precautions. All training should be tailored to meet the needs of the individuals in attendance. A training program that provides necessary instruction should be written and implemented.

MODEL PROGRAM

Personnel will be instructed:

1. Before assuming duties with, or in the vicinity of, radioactive materials.

2. During annual refresher training.

3. Whenever there is a significant change in duties, regulations, or the terms of the license or type of radioactive material or therapy device used.

Training for Professional Staff:

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Professional staff (AU's, AMP's, ANP's, RSO's, nurses, dosimetrists, technologists, therapists) providing or involved in the care of patients during diagnostic or therapeutic procedures in the care of patients will be instructed in the following topics, commensurate with their duties:

1. Radiation biology, e.g. interaction of ionizing radiation with cells, tissues, and organs;
2. Radiation physics, to include concepts of time, distance, and shielding;
3. Risk estimates, including comparison with other health risks so that nurses will have an understanding of the risks involved and respond appropriately, rather than react from excessive fear or lack of concern;
4. ALARA concept;
5. Posting requirements;
6. Proper use of personnel dosimetry (when applicable);
7. Instruction in procedures for reacting to medical emergencies or patient death, including notification of appropriate medical personnel and the RSO and AU(the intent of these procedures should in no way interfere with or be in lieu of appropriate patient care);
8. Occupational dose limits and their significance (180 NAC 1-004.12);
9. Dose to embryo/fetus limits including instruction sheet about declaration of pregnancy (180 NAC 1-004.13).
10. Dose to individual members of the public (180 NAC 1-004.14)
11. Workers right to be informed of occupational radiation exposure (180 NAC 1-010.04);
12. Each individuals obligation to report unsafe conditions to the RSO (180 NAC 1-010.03);
13. Applicable regulations, license conditions, information notices, bulletins, etc.;
14. Location where copies of the applicable regulations, the Agency license and its application are posted or made available for examination;
15. Proper record keeping;
16. Access control procedures;
17. Proper use of radiation shielding, if used;
18. Patient release procedures;
19. Appropriate surveys to be conducted, including surveys of all material; leaving radioactive material areas;
20. Proper use of required survey instruments;
21. Emergency procedures;
22. Decontamination and release of facilities and equipment;
23. Licensee's operating procedures (such as survey requirements, instrument calibration, waste management, and sealed source leak

testing);
24. Previous incidents, events and/or accidents; and
25. Questions and answers

Training for Staff Involved in Therapy or Therapeutic Treatment Planning:

In addition to the topics specified in the previous section, staff (AU's, AMP's, RSO's, nurses, dosimetrists) involved in the therapy treatment of patients will be instructed in the following topics, commensurate with their duties:

1. Leak testing of sealed sources;
2. Emergency response drills to reinforce emergency procedure skills;
3. Operating instructions;
4. Computerized treatment planning system;
5. Dosimetry protocols;
6. Detailed pretreatment quality assurance checks;
7. Safe handling of the patient's dishes, linens, excretions and surgical dressings that are potentially contaminated or that may contain radioactive contamination;
8. Patient control procedures;
9. Visitor control procedures, such as visitor stay times and safe lines in radiation control areas (patient rooms);
10. Licensee's procedures especially those involving patient identity verification, source and applicator positioning;
11. Proper use of safety devices and shielding to include safe handling and shielding of dislodged sources or disconnected sources for remote afterloaders;
12. Size and appearance of different sources and types of applicators;
13. For remote afterloaders, teletherapy units, and gamma stereotactic units; initial training provided by the device manufacturers or by individuals certified by the device manufacturer that is device model specific and includes:

    - Design, use, and function of the device, including safety systems and interpretation of various error codes/conditions, displays, indicators, and alarms
    - Hands-on training in actual operations of the device under the direct supervision of an experienced user including "dry runs" (using dummy sources) of routine patient setup/treatment and implementation of the licensees emergency procedures.

- A method of determining each trainee's competency to use the device for each type of proposed use, such as practical examinations.

Additional Training for Authorized Teletherapy/Medical Physicists (AMP):

In addition to the training and experience requirements of 180 NAC 1-007.66J it will be verified that the AMP has specific training and experience in performing the measurements and calculations associated with the specific type of therapy treatments that the license covers (for example manual brachytherapy, remote afterloader therapy, teletherapy, gamma stereotactic radiosurgery therapy) and that the training involved the use of the treatment planning system in use onsite.

Additional Training for Therapy Authorized Users:

In addition to the training and experience requirements of 180 NAC 1, it will be verified that the therapy physician has specific training and experience in performing the specific therapy treatment covered in the license application including training on the treatment planning system, quality control system and clinical procedure that will be used onsite.

Training for Contractors:

Individuals working under a contractual arrangement will be instructed as described above, equivalent to instruction given to facility employees and commensurate with their duties.

Training for Ancillary Staff

Ancillary staff include housekeeping, dietary services, laboratory services, security and custodial staff.

For individuals whose assigned activities during normal and abnormal situations are likely to result in an occupational dose, instruction will be provided commensurate with potential radiological health problems present in the workplace. Alternatively, these personnel could be prohibited from entering restricted or controlled areas unless escorted by trained personnel. Topics of instruction will include:

1. Applicable regulations and license conditions.

2. Areas where radioactive material is used or stored.

3. Potential hazards associated with radioactive material in each area where the employees will work.

4. Appropriate radiation safety procedures.

5. Licensee's in-house work rules.

6. Each individual's obligation to report unsafe conditions to the Radiation Safety Officer.

7. Appropriate response to emergencies or unsafe conditions.

8. Worker's right to be informed of occupational radiation exposure and bioassay results.

9. Locations where the licensee has posted or made available notices, copies of pertinent regulations, and copies of pertinent licenses and license conditions (including applications and applicable correspondence), as required by 180 NAC 1-010.

10. Notice to Employees (NRH-3)

11. Question and answer period.

APPENDIX B1

MODEL RADIATION SAFETY COMMITTEE CHARTER AND RADIATION SAFETY OFFICER DELEGATION OF AUTHORITY

You may use the following text as it appears here, stating on your application, "We will issue the model Radiation Safety Committee Charter and Radiation Safety Officer Delegation of Authority that was published in Appendix B1 to Regulatory Guide 7.0."

If you prefer, you may develop your own statement of authority, duties, administrative procedures, and delegation of authority. If you do so, you should consider for inclusion all the features in the model text and carefully review the requirements of 180 NAC 1-007.11. Say on your application, "We will issue the Radiation Safety Committee Charter and Radiation Safety Officer Delegation of Authority that are appended as Attachment 7," and append your charter and delegation.

MODEL CHARTER

Charge. The Committee shall:

1. Ensure that radioactive material will be used safely. This includes review as necessary of training programs, equipment, facility, supplies, and procedures;

2. Ensure that radioactive material is used in compliance with 180 NAC 1 and the institutional license;

3. Ensure that the use of radioactive material is consistent with the ALARA philosophy and program;

4. Establish a table of investigational levels for individual occupational radiation exposures; and

5. Identify program problems and solutions.

Responsibilities. The Committee shall:

1. Be familiar with all pertinent 180 NAC 1 regulations, the license application, the license, and amendments;

2. Review the training and experience of the proposed authorized users, the Radiation Safety Officer (RSO), and the medical physicist to determine that their qualifications are sufficient to enable the individuals to perform their duties safely and are in accordance with the regulations and the license;

3. Review on the basis of safety and approve or deny, consistent with the limitations of the regulations, the license, and the ALARA philosophy, all requests for authorization to use radioactive material within the institution;

4. Prescribe special conditions that will be required during a proposed method of use of radioactive material such as requirements for bioassays, physical examinations of users, and special monitoring procedures;

5. Review quarterly the RSO's summary report of the occupational radiation exposure records of all personnel, giving attention to individuals or groups of workers whose occupational exposure appears excessive;

6. Establish a program to ensure that all persons whose duties may require them to work in or frequent areas where radioactive materials are used (e.g., nursing, security, housekeeping, physical plant) are appropriately instructed as required in 180 NAC 1-010.03;

7. Review at least annually the RSO's summary report of the entire radiation safety program to determine that all activities are being conducted safely, in accordance with Agency regulations and the conditions of the license, and consistent with the ALARA program and philosophy. The review must included an examination of records, reports from the RSO, results of Agency inspections, written safety procedures, and the adequacy of the management control system;

8. Recommend remedial action to correct any deficiencies identified in the radiation safety program;

9. Maintain written minutes of all Committee meetings, including members in attendance and members absent, discussions, actions, recommendations, decisions, and numerical results of all votes taken; and

10. Ensure that the radioactive material license is amended if required prior to any changes in facilities, equipment, policies, procedures, and personnel.

Administrative Information

1. The Committee shall meet as often as necessary to conduct its business but not less than once in each calendar quarter.

2. Membership must include one authorized user for each type of use authorized by the license, the RSO, a representative of the nursing service, and a representative of management who is neither an authorized user nor an RSO. Management may appoint alternate members to participate in meetings in the case of absence of principal members and should consider appointing as adjunct members representatives from security, physical plant, housekeeping, and other departments. (Adjunct members should abstain from balloting on radiation safety technical questions such as Items 2 through 5 in the "Responsibilities" section above.)

3. To establish a quorum, one-half of the Committee's membership, including the RSO and the management representative, must be present.

4. To the extent that they do not interfere with the mission of the Committee, management may assign other responsibilities such as x-ray radiation safety, quality assurance oversight, and research project review and approval.

MODEL DELEGATION OF AUTHORITY

Memo To: Radiation Safety Officer
From: Chief Executive Officer
Subject: Delegation of Authority

You, _____ have been appointed Radiation Safety Officer and are responsible for ensuring the safe use of radiation. You are responsible for managing the radiation protection program; identifying radiation safety problems; initiating, recommending, or providing corrective actions; verifying implementation of corrective actions; stopping unsafe activities; and ensuring compliance with regulations. You are hereby delegated the authority necessary to meet those responsibilities, including prohibiting the use of byproduct material by employees who do not meet the necessary requirements and shutting down operations where justified by radiation safety. You are required to notify management of situations where staff are not cooperating and not addressing radiation safety issues. In addition, you are free to raise issues with Nebraska Health and Human Services Regulation and Licensure at anytime. It is estimated that you will spend _____ hours per week conducting radiation protection activities.

_____
Signature of Management Representative

I accept the above responsibilities,

_____
Signature of Radiation Safety Officer

cc:Affected department heads

APPENDIX B2

CONSIDERATIONS IN MAKING RADIATION SAFETY PROGRAM CHANGES

The regulations permit the licensee to make changes that will not adversely affect radiation safety procedures or equipment. When making changes, it is the licensee's responsibility to ensure that the result will be in accord with the regulations and license conditions. Any change must be reviewed for radiation safety considerations before it is approved.

Amendments to the license are necessary when the licensee proposes to change:

1. Policy
2. Equipment or facilities
3. Personnel
4. Radiation Safety Procedures
5. Licensed Material or Quantities and Form
6. Location
7. Authorized User

You should consider the following before making an application for a license amendment or making changes.

General

1. Proposed changes should be fully explained.

2. Do not include unexplained acronyms, abbreviations, or undefined words.

3. Spell out measurement units such as millicurie, microcurie, and millirem per hour; use the abbreviations only in calculations or log sheets.

4. Identify, by name or office, who is responsible for doing each task.

Room Changes

1. Why is the change needed?

2. What materials, and how much of each, will be used in the room?

3. Can the room be secured in case of spills?

4. Can the room surfaces be cleaned?

5. Is the room adequately ventilated?

6. Does the room provide radiation shielding?

7. What are the anticipated doses each week in the room and in surrounding areas?

8. What are surrounding areas used for? What might they be used for in the future?

9. Can the old room be decontaminated, surveyed, and released for unrestricted use?

Equipment Changes

1. Why is the change needed?

2. Was the equipment designed for the intended purpose?

3. For detection and measuring equipment:

   a. What is the lowest level of detection for the equipment?

   b. What is the level of detection required?

   c. Will the instrument be compromised by ambient radiations, light, temperature, humidity, or chemicals in the area?

   d. In case it fails, is backup equipment available, and can it be repaired in a timely fashion?

4. For protection equipment:

   a. What level of protection does it provide?

   b. What is the required level of protection?

   c. In case it fails, is backup equipment available, and can it be repaired in a timely fashion?

Procedure Changes

1. Why is the change needed?

2. What doses or dose rates apply to the individuals affected by the change?

3. For each step in the procedure, what things may go wrong either because of equipment failure or human error?

4. What are the likely consequences of problems noted in Question 3?

5. What steps can be taken to mitigate the consequences noted in Question 4?

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APPENDIX B3

MODEL PROGRAM FOR MAINTAINING OCCUPATIONAL RADIATION EXPOSURE AT MEDICAL INSTITUTIONS ALARA

You may use the text as it appears here, saying on your application, "We will establish and implement the model ALARA program that was published in Appendix B3 to Regulatory Guide 7.0."

If you prefer, you may develop your own ALARA program for Agency review. If you do you should consider for inclusion all the features in the model. Say on your application, "We have developed an ALARA program for your review that is appended as Attachment 7," and append your program.

ALARA PROGRAM

(Licensee's Name)

(Date)

1. Management Commitment

   a. We, the management of this (medical facility, hospital, etc.), are committed to the program described herein for keeping individual and collective doses as low as is reasonably achievable (ALARA). In accord with this commitment, we hereby describe an administrative organization for radiation safety and will develop the necessary written policy, procedures, and instructions to foster the ALARA concept within our institution. The organization will include a Radiation Safety Committee (RSC) and a Radiation Safety Officer (RSO).

   b. We will perform a formal annual review of the radiation safety program, including ALARA considerations. This will include reviews of operation procedures and past dose records, inspections, etc., and consultations with the radiation safety staff or outside consultants.

   c. Modifications to operating and maintenance procedures and to equipment and facilities will be made if they will reduce exposures unless the cost, in our judgment, is considered to be unjustified. We will be able to demonstrate, if necessary, that improvements have been sought, that modifications have been considered, and that they have been implemented when reasonable. If modifications have been recommended but not implemented, we will be prepared to describe the reasons for not implementing them.

d. In addition to maintaining doses to individuals as far below the limits as is reasonably achievable, the sum of the doses received by all exposed individuals will also be maintained at the lowest practicable level. It would not be desirable, for example, to hold the highest doses to individuals to some fraction of the applicable limit if this involved exposing additional people and significantly increasing the sum of radiation doses received by all involved individuals.

2. Radiation Safety Committee

a. Review of Proposed Users and Uses

(1) The RSC will thoroughly review the qualifications of each applicant with respect to the types and quantities of materials and methods of use for which application has been made to ensure that the applicant will be able to take appropriate measures to maintain exposure ALARA.

(2) When considering a new use of radioactive material, the RSC will review the efforts of the applicant to maintain exposure ALARA.

(3) The RSC will ensure that the users justify their procedures and that individual and collective doses will be ALARA.

b. Delegation of Authority

(The judicious delegation of RSC authority is essential to the enforcement of an ALARA program.)

(1) The RSC will delegate authority to the RSO for enforcement of the ALARA concept.

(2) The RSC will support the RSO when it is necessary for the RSO to assert authority. If the RSC has overruled the RSO, it will record the basis for its action in the minutes of the quarterly meeting.

c. Review of ALARA Program

(1) The RSC will encourage all users to review current procedures and develop new procedures as appropriate to implement the ALARA concept.

(2) The RSC will perform a quarterly review of occupational radiation exposure with particular attention to instances in which the investigational levels in Table 1 are exceeded. The principal purpose of this review is to assess trends in occupational exposure as an index of the ALARA program quality and to decide if action is

warranted when investigational levels are exceeded (see Section 6 below for a discussion of investigational levels).*

*The NRC has emphasized that the investigational levels in this program are not new dose limits but, as noted in ICRP Report 26, "Recommendations of the International Commission on Radiological Protection," serve as check points above which the results are considered sufficiently important to justify investigations.

TABLE 1

INVESTIGATIONAL LEVELS

	Investigational Levels (mrems per calendar quarter)	
	Level I	Level II
1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	125	375
2. Hands and forearms; feet and ankles	1875	5625
3. Skin of whole body*	750	2250

*Not normally applicable to medical use operations except those using significant quantities of beta-emitting isotopes.

(3) The RSC will evaluate our institution's overall efforts for maintaining doses ALARA on an annual basis. This review will include the efforts of the RSO, authorized users, and workers as well as those of management.

3. Radiation Safety Officer

a. Annual and Quarterly Review

(1) Annual review of the radiation safety program. The RSO will perform an annual review of the radiation safety program for adherence to ALARA concepts. Reviews of specific methods of use may be conducted on a more frequent basis.

(2) Quarterly review of occupational exposures. The RSO will review at least quarterly the external radiation doses of authorized users and workers to determine that

their doses are ALARA in accordance with the provisions of Section 6 of this program and will prepare a summary report for the RSC.

(3) Quarterly review of records of radiation surveys. The RSO will review radiation surveys in unrestricted and restricted areas to determine that dose rates and amounts of contamination were at ALARA levels during the previous quarter and will prepare a summary report for the RSC.

b. Education Responsibilities for ALARA Program

(1) The RSO will schedule briefings and educational sessions to inform workers of ALARA program efforts.

(2) The RSO will ensure that authorized users, workers, and ancillary personnel who may be exposed to radiation will be instructed in the ALARA philosophy and informed that management, the RSC, and the RSO are committed to implementing the ALARA concept.

c. Cooperative Efforts for Development of ALARA Procedures

Radiation workers will be given opportunities to participate in formulating the procedures that they will be required to follow.

(1) The RSO will be in close contact with all users and workers in order to develop ALARA procedures for working with radioactive materials.

(2) The RSO will establish procedures for receiving and evaluating the suggestions of individual workers for improving health physics practices and will encourage the use of those procedures.

d. Reviewing Instances of Deviation from Good ALARA Practices

The RSO will investigate all known instances of deviation from good ALARA practices and, if possible, will determine the causes. When the cause is known, the RSO will implement changes in the program to maintain doses ALARA.

4. Authorized Users

a. New Methods of Use Involving Potential Radiation Doses

(1) The authorized user will consult with the RSO and/or RSC during the planning stage before using radioactive materials for new uses.

(2) The authorized user will review each planned use of radioactive materials to ensure that doses will be kept ALARA. Trial runs may be helpful.

b. Authorized User's Responsibility to Supervised Individuals

(1) The authorized user will explain the ALARA concept and the need to maintain exposures ALARA to all supervised individuals.

(2) The authorized user will ensure that supervised individuals who are subject to occupational radiation exposure are trained and educated in good health physics practices and in maintaining exposures ALARA.

5. Individuals Who Receive Occupational Radiation Doses

a. Workers will be instructed in the ALARA concept and its relationship to work procedures and work conditions.

b. Workers will be instructed in recourses available if they feel that ALARA is not being promoted on the job.

6. Establishment of Investigational Levels in Order to Monitor Individual Occupational External Radiation Doses

This institution hereby establishes investigational levels for occupational external radiation doses which, when exceeded, will initiate review or investigation by the RSC and/or the RSO. The investigational levels that we have adopted are listed in Table 1. These levels apply to the exposure of individual workers.

The RSO will review and record on Form NRH-2, "Current Occupational External Radiation Exposures," or an equivalent form (e.g., dosimeter processor's report) results of personnel monitoring not less than once in any calendar quarter. The following actions will be taken at the investigational levels as stated in Table 1:

a. Personnel dose less than Investigational Level I.

Except when deemed appropriate by the RSO, no further action will be taken in those cases where an individual's dose is less than Table 1 values for the Investigational Level I.

b. Personnel dose equal to or greater than Investigational Level I but less than Investigational Level II.

The RSO will review the dose of each individual whose quarterly dose equals or exceeds Investigational Level I and will report the results of the reviews at the first RSC meeting

following the quarter when the dose was recorded. If the dose does not equal or exceed Investigational Level II, no action related specifically to the exposure is required unless deemed appropriate by the Committee. The Committee will, however, review each such dose in comparison with those of others performing similar tasks as an index of ALARA program quality and will record the review in the Committee minutes.

c. Personnel dose equal to or greater than Investigational Level II.

The RSO will investigate in a timely manner the causes of all personnel doses equaling or exceeding Investigational Level II and, if warranted, will take action. A report of the investigation, any actions taken, and a copy of the individual's Form NRH-2 or its equivalent will be presented to the RSC at its first meeting following completion of the investigation. The details of these reports will be included in the RSC minutes.

d. Reestablishment of investigational levels to levels above those listed in Table 1.

In cases where a worker's or a group of workers' doses need to exceed an investigational level, a new, higher investigational level may be established for that individual or group on the basis that it is consistent with good ALARA practices. Justification for new investigational levels will be documented.

The RSC will review the justification for and must approve or disapprove all revisions of investigational levels.

7. Signature of Certifying Official*

I hereby certify that this institution has implemented the ALARA Program set forth above.

Signature

Name (print or type)

Title

*The person who is authorized to make commitments for the administration of the institution (e.g., hospital administrator.)

APPENDIX B4

MODEL RSO DUTIES AND RESPONSIBILITIES

The RSO's duties and responsibilities include ensuring radiological safety and compliance with State and DOT regulations and the conditions of the license. Typically, these duties and responsibilities include ensuring the following:

1. Activities involving licensed material that the RSO considers unsafe are stopped.
2. Radiation exposures are ALARA.
3. Up to date radiation protection procedures in the daily operation of the licensee's byproduct material program are developed, distributed, and implemented.
4. Possession, use and storage of licensed material is consistent with the limitations in the license, the regulations, the Sealed Source and Device Registry Certificates and the manufacturer's recommendations and instructions.
5. Individuals installing, relocating , maintaining, or repairing devices containing sealed sources are trained and authorized by an NRC or Agreement State license.
6. Personnel training is conducted and is commensurate with the individual's duties regarding licensed material.
7. Documentation is maintained that individuals are not likely to receive, in one year, a radiation dose in excess of 10% of the allowable limits or that personnel monitoring devices are provided.
8. When necessary, personnel monitoring devices are used and exchanged at the proper intervals, and records of such monitoring are maintained.
9. Licensed material is properly secured.
10. Documentation is maintained to demonstrate, by measurement or calibration, that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual limit for members of the public.
11. Proper authorities are notified of incidents such as loss or theft of licensed material, damage to or malfunction of sealed sources, or fire.
12. Medical events are investigated and reported to the State. Causes and appropriate corrective actions are identified.
13. Audits of the radiation protection program are performed at least annually and documented.
14. If violations of regulations or license conditions or program weaknesses are identified, effective corrective actions are developed, implemented and documented.
15. Licensed material is transported in accordance with all applicable DOT requirements.
16. Licensed material is disposed of properly.
17. Appropriate records are maintained.
18. Up to date licensing is maintained and amendment and renewal requests are submitted in a timely manner.

APPENDIX C

RECOMMENDED SUPPORT EQUIPMENT AND SERVICES

Depending on the type of use and the size of the program, you will need various types of equipment and services to support our radiation safety program. The suggested list provided here does not include the many disposable or reusable items that are also necessary. Also, the list is not all-inclusive, and all items are not absolutely necessary.

Needs are divided to correspond to the different types of medical uses of radioactive material described in 180 NAC 1-007. While instrumentation overlaps among subparts, duplication is generally not necessary unless an instrument is to be dedicated to a single area of use or a single user. Descriptions of some of the items follow the list.

180 NAC 1-007.34

1. Radiation detection survey meter
2. Dose Calibrator
3. Constancy check source
4. Sealed sources for dose calibrator accuracy test
5. Constancy check source for uptake, dilution, and excretion equipment
6. Leak-test service for sealed sources
7. Syringe shield
8. Personnel monitoring service
9. Survey meter calibration service
10. Vial shields
11. Personnel shields

180 NAC 1-007.36

1. Radiation detection survey meter
2. Radiation measurement survey meter
3. Dose Calibrator
4. Constancy check source
5. Sealed sources for dose calibrator accuracy test
6. Leak-test service for sealed sources
7. Syringe shield
8. Hot lab area monitor
9. Flood source for gamma cameras
10. PLES, bar, orthogonal-hole, or quadrant phantom for gamma cameras
11. Lead L-block
12. Fume hood
13. Radioactive aerosol and gas administration system and trap
14. Personnel monitoring service

15. Survey meter calibration service
16. Vial shields
17. Personnel shields

180 NAC 1-007.40

1. Radiation detection survey meter
2. Radiation measurement survey meter
3. Dose calibrator
4. Constancy check source
5. Sealed sources for dose calibrator accuracy test
6. Leak-test service for sealed sources
7. Syringe shield
8. Fume hood
9. Personnel monitoring service
10. Survey meter calibration service
11, Vial Shields
12. Personnel shields

180 NAC 1-007.44

1. Secure storage area
2. Leak-test service for sealed sources
3. Radiation monitoring service for measuring dose rates from packages with replacement sources and decayed sources.

180 NAC 1-007.46

1. Radiation detection survey meter
2. Radiation measurement survey meter
3. Lead L-block
4. Remote handling tools
5. Shielded transport cart
6. Shielded storage safe
7 Leak-test service for sealed sources
8. Personnel monitoring service
9. Survey meter calibration service
10. Personnel shields

NOTE: If you are authorized for only a Sr-90 ophthalmic applicator, only a storage safe or built-in locked storage cabinet and leak-test service are necessary.

Descriptions

A radiation detection survey meter usually has a GM tube or NaI(Tl) crystal detector. The scale may be labeled in cpm or mR/hr. It is useful for detecting microcurie amounts of radioactivity and indicating approximate exposure levels. If it is calibrated in mR/hr, the most sensitive scale will probably have a full-scale deflection between 0.1 and 1.0 mR/hr. It can be used for measuring small amounts of radioactivity if the user has measured its detection efficiency (cpm/dpm) for the radionuclide being measured.

A radiation measurement survey meter can actually measure mR/hr. The detector is an ionization chamber, which is usually much larger than a GM tube. The scale is labeled in mR/hr, and the most sensitive scale usually will have a full-scale deflection between 1 and 10 mR/hr.

Low energy beta emitters, such as carbon-14 and sulfur-35, are difficult to detect. A thin end window Geiger-Mueller (GM) probe gives a detection efficiency on the order of 10% for these two isotopes. Still lower energy beta emitters such as tritium are virtually undetectable without liquid scintillation counter swipes. Particular attention to surveying method (speed and height above the surface) is needed to perform adequate surveys. Additionally, wipes should be taken and counted on a liquid scintillation counter to verify potential contamination.

Medium to high energy beta emitters such as phosphorus-32 and calcium-45, can be detected with a pancake GM. The efficiency ranges from 15 to 40%, depending on the beta energy.

Low energy gamma emitters, such as Iodine-125, can be detected with a sodium iodide probe. If the probe possesses a thin window and thin crystal, the detection efficiency is approximately 20 to 40%.

Medium to high energy gamma emitters, such as technetium-99m, can be detected with either GM or sodium iodide probes, depending on the required sensitivity. The sensitivity of GM probes is much lower than that for sodium iodide probes, therefore sodium iodide probes are the preferred alternative.

The dose calibrator uses an ionization chamber or GM detectors to determine the amount of radiation given off by a syringe or vial containing radioactive material. The logic system within the calibrator can then calculate the amount of radioactivity in the sample. Most dose calibrators have a digital display with either a "select range" switch or an automatic range-switching circuit. The final display is in microcuries, millicuries, or curies. A dose calibrator can measure from a few microcuries to a few curies. It is not sensitive enough to measure contamination wipe samples.

A constancy check source is a sealed source with the date of manufacture, radioisotope, and approximate activity noted.

A dedicated check source is a long-lived radioactive source used to check the day-to-day constancy of an instrument. The same source (a "dedicated" source) must be used every day so that the user knows what reading to expect from the instrument. The source may also be used for other purposes.

The sealed sources for dose calibrator accuracy are also sealed sources with the date of manufacture and radioisotope noted. However, the activity will be certified to within a few percent by the manufacturer. These need not be on hand if the dose calibrator accuracy test is done by a contract service.

The leak-test service may be done in-house or performed as a contact service. Leak-test wipes cannot be measured in a dose calibrator, and a GM survey meter may not be sensitive enough to detect contamination on a wipe sample. Usually a well-type NaI(Tl) crystal with a ratemeter is necessary to assay gamma-emitter leak-test wipes, although a properly designed setup with a liquid scintillation counter would work for beta-gamma sources. To determine the efficiency of detection, a sealed source with the same radioisotope as the source being tested is used, but its activity should be between 0.1 and 10 microcuries. This activity will be certified by the manufacturer to an accuracy within a few percent.

The hot lab area monitor usually has a GM detector, and the scale may be labeled in cpm or mR/hr. It should be sufficiently sensitive to detect an patient dose left lying unshielded anywhere in the hot lab.

The flood source for gamma cameras may be either one that is sealed or one that is filled by the user. The sealed sources usually contain about 5 millicuries of Co-57. The sources that can be filled by the user usually have a removable screw in a port through which radioactive material can be injected each morning.

PLES, bar, orthogonal-hole, and quadrant phantoms are used to monitor geometric linearity and resolution capability in gamma cameras. This type of test should be run weekly according to the instructions supplied by the manufacturer or the instructions in Appendix N to this guide.

A fume hood should have an adjustable sash. It should be directly vented to the outside air. The face velocity should be approximately 100 linear feet per minute with the sash at its normal location. This should be measured with a velometer. If one is not available, hang a strip of tissue paper about 1 inch wide and 3 inches long from the bottom of the sash; at the proper face velocity, it will be gently deflected into the hood.

Personnel shields are used to shield workers from radioactive patients. They may be mobile upright shields in the nuclear medicine clinic or a patient's room when a technician or nurse must stay beside a patient, or they may be lead sheets used to shield transporters from patients in wheelchairs.

APPENDIX C
INSTRUMENTATION

1. Survey Meters (one grouping for radiation detection, another for radiation measurement):

   a. Manufacturer's name: _____

      Manufacturer's model number: _____

      Number of instruments available: _____

      Minimum range: _____mr/hr to _____mr/hr

      Maximum range: _____mr/hr to _____mr/hr

   b. Manufacturer's name: _____

      Manufacturer's model number: _____

      Number of instruments available: _____

      Minimum range: _____mr/hr to _____mr/hr

      Maximum range: _____mr/hr to _____mr/hr

2. Dose Calibrator:

   Manufacturer's name: _____

   Manufacturer's model number: _____

   Number of instruments available: _____

3. Diagnostic Instruments

Type of Instrument	Manufacturer's Name	Model No.

4. Other:

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APPENDIX D1

MODEL PROCEDURE FOR CALIBRATING SURVEY INSTRUMENTS

You or your contractor may use the following guidance to calibrate survey instruments. If you, or the contractor, follow all the guidance, you may say on your application, "We will establish and implement the model procedure for calibrating survey instruments that was published in Appendix D1 to Regulatory Guide 7.0."

If your procedure does not follow the guidance in the model, you may develop your own procedure for review. If you do so, you should consider for inclusion all the features in the model. Say on your application, "We have developed a survey instrument calibration procedure for your review that is appended as Attachment 10," and append your survey instrument calibration procedure.

MODEL PROCEDURE

Radiation survey meters should be calibrated with a radioactive source. Electronic calibrations alone are not acceptable. Survey meters must be calibrated at least annually, before first use and after servicing. (Battery changes are not considered "servicing.") Instruments used to monitor higher energies are most easily calibrated in known radiation fields produced by sources of gamma rays of approximately the same energies as those to be measured. An ideal calibration source should emit the applicable radiation (alpha, beta, or gamma) with an energy spectrum similar to that to be measured and have a suitably long half-life.

The radioactive sources used for calibrating survey instruments will:

1. Approximate a point source.

2. Have its apparent source activity or the exposure rate at a given distance traceable by documented measurements to a standard certified within 5 percent accuracy by the National Institute of Standards and Technology.

3. Emit the same type of radiation as that measured and approximate the same energy as the environment in which the calibrated device will be employed.

4. Provide a radiation dose rate sufficient to reach the full scale (<1000 mR/hr) of the instrument calibrated

The inverse square law and the radioactive decay law must be used to correct for change in exposure rate due to changes in distance or source decay.

A record must be made of each survey meter calibration and retained for 3 years after each record is made.

Instrument readings should be within +/- 10% of known radiation values at calibrated points; however, readings within +/- 20% shall be acceptable if a calibration chart or graph is prepared and made available with the instrument.

The kinds of scales frequently used on radiation survey meters are calibrated as follows:

1. Meters on which the user selects linear scales must be calibrated at no less than two points on each scale. The points should be at approximately 20% and 80% of each scale.

2. Logarithmic Readout Instruments must be calibrated at one point (midpoint) on each decade.

3. Digital readout Instruments with either manual or automatic scale switching for indicating exposure rates must be calibrated at no fewer than two points on each scale. Those points should be at approximately 20% and 80% of the decade.

4. Digital readout instruments without scale switching for indicating exposure rates must be calibrated at one point (midpoint) on each decade.

5. Integrating instruments must be calibrated at two dose rates (approximately 20% and 80% of the dose rate range).

Readings above 1,000 mR/hr need not be calibrated. However, such scales should be checked for operation and approximately correct response.

The report of a survey meter calibration should indicate the procedure used and the data obtained. The description of the calibration will include:

a. The owner or user of the instrument;

b. A description of the instrument that includes manufacturer, model number, serial number, and type of detector;

c. A description of the calibration source, including exposure rate at a specified distance on a specified date, and the calibration procedure;

d. For each calibration point, the calculated exposure rate, the indicated exposure rate, the deduced correction factor (the calculated exposure rate divided by the indicated exposure rate), and the scale selected on the instrument;

e. The reading indicated with the instrument in the "battery check" mode (if available on the instrument);

f. The angle between the radiation flux field and the detector (for external cylindrical GM or ionization-type detectors, this will usually be "parallel" or "perpendicular" indicating photons traveling either parallel with or perpendicular to the central axis of the detector; for instruments with internal detectors, this should be the angle between the flux field and a specified surface of the instrument);

g. For detectors with removable shielding, an indication of whether the shielding was in place or removed during the calibration procedure;

h. The apparent exposure rate from the check source (if used); and

i. The name of the person who performed the calibration and the date on which the calibration was performed.

The following information will be attached to the instrument as a calibration sticker or tag:

a. The source that was used to calibrate the instrument;

b. The proper deflection in the battery check mode (unless this is clearly indicated on the instrument);

c. For each scale or decade, one of the following as appropriate:

(1) The average correction factor,

(2) A graph or graphs from which the correction factor for each scale or decade may be deduced, or

(3) An indication that the scale was checked for function but not calibrated or an indication that the scale was inoperative;

d. The date of calibration and the next calibration due date; and

e. The apparent exposure rate from the check source.

Note: One-word reminders or symbols that are explained on the Survey Meter Calibration Report may be used on the calibration sticker.

See Exhibit 7 for a form you may want to use.

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APPENDIX D2

MODEL PROCEDURE FOR CALIBRATING DOSE CALIBRATORS

You or your contractor may use the following model procedure for checking and testing the dose calibrator. If you, or the contractor, follow the model procedure, you may say on your application, "We will establish and implement the model procedure for calibrating our dose calibrator that was published in Appendix D2 to Regulatory Guide 7.0."

If you develop your own dose calibrator calibration procedure for review. Say on your application, "We have developed a dose calibrator calibration procedure for your review that is appended as Attachment 10b," and append your dose calibrator calibration procedure.

MODEL PROCEDURE

1. Test for the following at the indicated frequency. Consider repair, replacement, or arithmetic correction if the dose calibrator falls outside the suggested tolerances. The name of the individual who performed the test will be recorded for all tests. (A licensee shall repair or replace the dose calibrator if the accuracy or constancy error exceeds 10% and shall mathematically correct dosage reading (for dosages greater than 30 microcuries) if the geometry or linearity error exceeds 10%.)

    a. Constancy at least once each day prior to assay of patient dosages (±10 percent).

    b. Linearity at installation and at least quarterly thereafter (±10 percent).

    c. Geometry dependence at installation (±10 percent).

    d. Accuracy at installation and at least annually thereafter (±10 percent).

2. After repair, adjustment, or relocation to another building of the dose calibrator, repeat the above tests before use.

3. Constancy means reproducibility in measuring a constant source over a long period time. Assay at least one relatively long-lived source such as Cs-137, Co-60, Co-57, or Ra-226 using a reproducible geometry each day before using the calibrator. Consider the use of two or more sources with different photon energies and activities. Use the following procedure:

    a. Assay each reference source using the appropriate dose calibrator setting (i.e., use the Cs-137 setting to assay Cs-137).

    b. Measure background at the same setting, and subtract or confirm the proper operation of the automatic background subtract circuit if it is used.

c. For each source used, either plot on graph paper or log in a book the activity measured, the model and serial number of the instrument, the identity of the radionuclide contained in the check source, and the date of the check.

d. Using one of the sources, repeat the above procedure for all commonly used radioisotope settings. Plot or log the results.

e. Notify the RSO or the AU if the test results fall outside +/- 10% of the expected results.

4. Linearity means that the calibrator is able to indicate the correct activity over the range of use of that calibrator. The linearity of a dose calibrator is ascertained over it's use range between the maximum activity administered and 30 microcuries. This test is done using a vial or syringe of Tc-99m whose activity is at least as large as the maximum activity normally assayed for administration.

Time Decay Method

a. Assay the Tc-99m syringe or vial in the dose calibrator, and subtract background to obtain the net activity in millicuries. Record the date, time to the nearest minute, and net activity on the Dose Calibrator Linearity Test Form (see Exhibit 8).

b. Repeat the assay at approximately four hour intervals during the workday. Continue on subsequent days until the assayed activity is less than 30 microcuries. For dose calibrators on which you select a range with a switch, select the range you would normally use for the measurement.

c. Convert the time and date information you recorded to hours elapsed since the first assay.

d. Record the measured activities, the calculated activities, the time elapsed between measurements, the model number and serial number of the dose calibrator, and the dates of the test.

e. Notify the RSO if the worst deviation is more than +/- 10%.

Shield Method

If you decide to use a set of "sleeves" of various thickness to test for linearity, it will first be necessary to calibrate them. You should review the procedure for calibrating sleeves against the manufacturer's instructions. Some sleeve manufacturer's procedures indicate that various sleeves should be stacked to achieve a desired attenuation. In this case procedure modifications may be necessary.

a. Begin the linearity test as described in the decay method described above. After making the first assay, the sleeves can be calibrated as follows. Steps b through d below must be completed within 6 minutes (approximately 1% of the half-life of Tc-99m)

b. Put the base and sleeve 1 in the dose calibrator with the vial. Record the sleeve number and indicated activity.

c. Remove sleeve 1 and put in sleeve 2. Record the sleeve number and indicated activity.

d. Continue for all sleeves.

e. Complete the decay method linearity test steps b through e above.

f. From the data recorded in step d of the decay method, find the decay time associated with the activity indicated with sleeve 1 in place. This is the "equivalent decay time" for sleeve 1. Record that time with the data recorded in step b.

g. Find the decay time associated with the activity indicated with sleeve 2 in place. This is the "equivalent decay time" for sleeve 2. Record that time with the data recorded in step c.

h. Continue for all sleeves.

i. The table of sleeve numbers and equivalent decay times constitutes the calibration of the sleeve set.

The sleeve set may now be used to test dose calibrators for linearity.

a. Assay the Tc-99m syringe or vial in the dose calibrator, and subtract background to obtain the net activity in millicuries. Record the net activity.

b. Steps c through e below must be completed within 6 minutes.

c. Put the base and sleeve 1 in the dose calibrator with the vial. Record the sleeve number and indicated activity.

d. Remove sleeve 1 and put in sleeve 2. Record the sleeve number and indicated activity.

e. Continue for all sleeves.

f. Record the measured activities, the calculated activities, the time elapsed between measurements, the model number and serial number of the dose calibrator, and the dates of the test.

g. Notify the RSO if the worst deviation is more than +/- 10%.

5. Geometry independence means that the indicated activity does not change with volume or configuration. This test should be done using syringes and vials that are representative of the entire range of size, shape, and constructions normally used for injections and a vial similar in size, shape, and construction to the generator and radiopharmaceutical kit vials normally used. The following test assumes injections are done with 3-cc plastic syringes and that radiopharmaceutical kits are made in 30-cc glass vials and the predetermined safety margin is +/- 10%. If you do not use these, change the procedure so that your syringes and vials are tested throughout the range of volumes commonly used.

a. In a small beaker or vial, mix 2 cc of a solution of Tc-99m with an activity concentration between 1 and 10 mCi/ml. Set out a second small beaker or vial with water.

b. Draw 0.5 cc of the Tc-99m solution into the syringe and assay it. Record the volume and activity (millicuries) indicated.

c. Remove the syringe from the calibrator, draw an additional 0.5 cc of water, and assay again. Record the volume and activity indicated.

d. Repeat the process until you have assayed a 2.0-cc volume.

e. Select as a standard the volume closest to that normally used for injections. For all the other volumes, divide the standard millicuries by the millicuries indicated for each volume. The quotient is a volume correction factor. Alternatively, you may graph the data and draw horizontal 5 percent error lines above and below the chosen "standard volume."

f. Record the model and serial number of the dose calibrator, the configuration of the source measured, the activity measured for each volume measured, and the date of the test.

g. Notify the RSO if any correction factors are greater than 1.1 or less than 0.9, or if any data points lie outside the +/- 10% percent error lines.

h. To test the geometry dependence for a 30-cc glass vial, draw 1.0 cc of the Tc-99m solution into a syringe and then inject it into the vial. Assay the vial. Record the volume and activity indicated.

i. Remove the vial from the calibrator and, using a clean syringe, inject 2.0 cc of water, and assay again. Record the volume and activity indicated.

j. Repeat the process until you have assayed a 19.0-cc volume. The entire process must be completed within 10 minutes.

k. Select as a standard the volume closest to that normally used for mixing radiopharmaceutical kits. For all the other volumes, divide the standard activity by the activity indicated for each volume. The quotient is a volume correction factor. Alternatively, you may graph the data and draw horizontal 10 % error lines above and below the chosen "standard volume."

l. Record the model and serial numbers of the dose calibrator, the configuration of the source measured, the activity measured for the volume measured, and the date of the test.

m. Notify the RSO if any correction factors are greater than 1.1 or less than 0.9 or if any data points lie outside the +/- 10 percent error lines.

6. Accuracy means that, for a given calibrated reference source, the indicated activity (millicurie) value is equal to the activity value determined by the National Institute of Standards and Technology (NIST) or by the supplier who has compared that source to a source that was calibrated by the NIST. Certified sources are available from the NIST and from many radioisotope suppliers. At least one source with a principal photon energy between 100 keV and 500 keV (such as Co-57 or Ba-133) should be used. Consider using at least one reference source whose activity is within the range of activities normally assayed.

a. Assay a calibrated reference source at the appropriate setting (i.e., use the Co-57 setting to assay Co-57), and then remove the source and measure background. Subtract background from the indicated activity to obtain the net activity. Record the net activity.

b. The measurement should be within +/-10% of the certified activity of the reference source mathematically corrected for decay.

c. Repeat the procedure for any other calibrated reference sources possessed.

d. Record the model and serial number of the dose calibrator, the model and serial number of each source used, the identity of the radionuclide contained in the source and its activity, the date of the test, and the results of the test.

e. Notify the RSO if the test results do not agree, within +/-10%, with the certified value of the reference source(s).

f. At the same time the accuracy test is done, assay the source that will be used for the daily constancy test (it need not be a certified reference source) on all commonly used radioisotope settings.

7. The licensee will through the RSO, ensure the operation of the dose calibrator is in accordance with approved procedures and regulatory requirements.

See Exhibits 8 and 9 for some forms you may want to use.

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APPENDIX E

MODEL GUIDANCE FOR ORDERING AND RECEIVING RADIOACTIVE MATERIAL

You may use the following guidance to control the ordering and receipt of radioactive material. If you follow all the guidance, you may say on your application, "We will establish and implement the model guidance for ordering and receiving radioactive material that was published in Appendix E to Regulatory Guide 7.0."

If your procedure does not follow all the guidance in the model, you may develop your own procedure for review. If you do so, you should consider for inclusion all the features in the model and carefully review the requirements of 180 NAC 1-004.32. Say on your application, "We have developed a procedure for ordering and receiving radioactive material for your review that is appended as Attachment 13," and append your procedure for ordering and receiving radioactive material.

MODEL GUIDANCE

1. The Radiation Safety Officer (RSO) or a designee must authorize each order for radioactive materials and ensure that the requested materials and quantities are authorized by the license for use by the requesting authorized user and that possession limits are not exceeded.

2. The RSO will establish and maintain a system for ordering and receiving radioactive material. The system must contain the following information:

   a. Written records that identify the authorized user or department, radionuclide, physical and/or chemical form, activity, and supplier

   b. Confirmation through the above records, that the material received was ordered through proper channels

3. For deliveries during normal working hours, the RSO will tell carriers to deliver radioactive packages directly to a specified area.

4. For deliveries during off-duty hours, the RSO will tell security personnel or other designated persons to accept delivery of radioactive packages in accordance with procedures outlined in the sample memorandum for delivery of packages to the Nuclear Medicine Division, provided below. A similar memorandum will be developed for delivery of packages to other divisions.

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Sample Memorandum

MEMO TO: Chief of Security
FROM: Radiation Safety Officer
SUBJECT: Receipt of Packages Containing Radioactive Material

The security guard on duty shall accept delivery of radioactive material that arrives outside normal working hours. Packages should be placed on a cart or wheelchair and taken immediately to the Nuclear Medicine Division, Room ____. Unlock the door, place the package on top of the counter, and relock the door.

If the package appears to be damaged, immediately contact one of the individuals identified below. Ask the carrier to remain at the hospital until it can be determined that neither the driver nor the delivery vehicle is contaminated.

If you have any questions concerning this memorandum, please call our hospital Radiation Safety Officer, _____, at extension _____.

Name Home Telephone

Radiation Safety Officer: _____
Director of Nuclear Medicine: _____
Nuclear Medicine Technologist Supervisor: _____
Nuclear Medicine Technologist on call
(call page operator at extension _____)
Nuclear Medicine Physician on call
(call page operator at extension_____)

APPENDIX F

MODEL PROCEDURE FOR SAFELY OPENING PACKAGES CONTAINING RADIOACTIVE MATERIAL

You may use the following model procedure for opening packages. If you follow the model procedure, you may say on your application, "We will establish and implement the model procedure for opening packages that was published in Appendix F to Regulatory Guide 7.0."

If you develop your own package opening procedure for review, you should consider for inclusion all the features in the model. Say on your application, "We have developed a package opening procedure for your review that is appended as Attachment 14," and append your package opening procedure.

MODEL PROCEDURE

1. Special requirements must be followed for packages containing quantities of radioactive material in excess of the Type A quantity limits specified in 180 NAC 1-013 Appendix A (Table A-1). Such packages must be received expeditiously when the carrier offers it for delivery or when the carrier notifies the licensee that the package has arrived at the carrier's terminal. For these and other packages that are so required, monitoring for external radiation levels and surface contamination must be performed within 3 hours after receipt if received during working hours or no later than 3 hours from the beginning of the next working day (if received after working hours), in accordance with the requirements of 180 NAC 1-004.32B2 through 004.32B3. The Agency must be notified if removable contamination exceeds 22dpm/cm^2 of beta and gamma emitters, 2.2 dpm/cm^2 of alpha emitters or if the package exceeds the external radiation level limits in 180 NAC 1-13.15.

2. For packages received under the specific license, the following procedure for opening each package will be followed:

   a. Put on gloves to prevent hand contamination.

   b. Visually inspect the package for any sign of damage (e.g., wet or crushed). If damage is noted, stop the procedure and notify the Radiation Safety Officer (RSO).

   c. Monitor the external surfaces of a labeled package for radioactive contamination, unless the package contains only radioactive material in the form of a gas or in special form, as defined in 180 NAC 1-001.02.

   d. Monitor the external surfaces of a labeled package for radiation levels, unless the package contains quantities of radioactive material that are less than or equal to the Type A quantity, as defined in 180 NAC 1-13.02 and 180 NAC 1-013 Appendix A (Table A-1).

e. Monitor all packages known to contain radioactive material for radioactive contamination and radiation levels, if there is evidence of degradation of package integrity, such as packages that are crushed, wet or damaged.

f. Open the package with the following precautionary steps:

(1) Remove the packing slip.

(2) Open the outer package following the supplier's instructions, if provided.

(3) Open the inner package and verify that the contents agree with the packing slip.

(4) Check the integrity of the final source container. Look for broken seals or vials, loss of liquid, condensation, or discoloration of the packing material.

(5) If anything is other than expected, stop and notify the RSO.

g. If there is any reason to suspect contamination, wipe the external surface of the final source container and remove the wipe sample to a low-background area. Assay the wipe sample to determine if there is any removable radioactivity. An appropriate instrument with sufficient sensitivity will be used to assay the sample. For example a sodium iodide crystal and ratemeter, a liquid scintillation counter, or a proportional flow counter may be used for these assays. The detection efficiency must be determined to convert wipe sample counts per minute to disintegrations per minute. (Note that a dose calibrator is not sufficiently sensitive for this measurement.) Take precautions against the potential spread of contamination.

h. Check the user request to ensure that the material received is the material that was ordered.

i. Monitor the packing material and the empty packages for contamination with a radiation detection survey meter before discarding.

(1) If contaminated, treat this material as radioactive waste.

(2) If not contaminated, remove or obliterate the radiation labels before discarding in in-house trash.

h. Make a record of the receipt.

3. For packages received under the general license in 180 NAC 1-003.07I, the following procedure for opening each package will be followed:

a. Visually inspect the package for any sign of damage (e.g., wet or crushed). If damage is noted, stop the procedure and notify the RSO.

b. Check to ensure that the material received is the material that was ordered.

See Exhibit 12 for a sample record form you may want to use.

APPENDIX G

MODEL RULES FOR SAFE USE OF RADIOPHARMACEUTICALS

You may use the following model rules as they appear here, saying on your application, "We will establish and implement the model safety rules published in Appendix G to Regulatory Guide 7.0".

If you prefer, you may develop your own rules for safe use of radiopharmaceuticals for review. If you do so, you should consider for inclusion, all the items in the model rules and carefully review the requirements of 180 NAC 1-007. Say on your application, "We have developed rules for the safe use of radiopharmaceuticals for your review that are appended as Attachment 15," and append your model rules for the safe use of radiopharmaceuticals.

MODEL RULES

1. Wear laboratory coats or other protective clothing at all times in areas where radioactive materials are used.

2. Wear disposable gloves at all times while handling radioactive materials.

3. Either after each procedure or before leaving the area, monitor your hands for contamination in a low-background area with an appropriate survey instrument.

4. Use syringe shields for reconstitution of radiopharmaceutical kits and administration of radiopharmaceuticals to patients, except in those circumstances in which their use is contraindicated (e.g., recessed veins, infants). In these exceptional cases, consider the use of other protective methods such as remote delivery of the dose (e.g., through use of a butterfly valve).

5. Do not eat, store food, drink, smoke, or apply cosmetics in any area where licensed material is stored or used.

6. Wear personnel monitoring devices, if required, at all times while in areas where radioactive materials are used or stored. These devices should be worn as prescribed by the Radiation Safety Officer. When not being worn to monitor occupational exposures, personnel monitoring devices should be stored in the work place in a designated low-background area.

7. Wear a finger exposure monitor (TLD), if required, during the elution of generators; during the preparation, assay, and injection of radiopharmaceuticals; and when holding patients during procedures, and when handling radioactive material.

8. Dispose of radioactive waste only in designated, labeled, and properly shielded receptacles.

9. Never pipette by mouth.

10. Wipe-test radioactive unsealed radioactive material storage, preparation, and administration areas weekly for contamination. If necessary, decontaminate or secure the area for decay.

11. With a radiation detection survey meter, survey all areas of licensed material use, including the generator storage, kit preparation, and injection areas daily for contamination. If necessary, decontaminate or secure the area for decay as appropriate. Areas used to prepare and administer therapy quantities of radiopharmaceuticals must be surveyed daily in accordance with 180 NAC 1-007.29 (except when administering therapy dosages in patients' rooms).

12. Store radioactive solutions in shielded containers that are clearly labeled.

13. Radiopharmaceutical multidose diagnostic vials and therapy vials should be labeled in accordance with 180 NAC 1-007.28 and 004.30, with the radionuclide, the activity, the date for which the activity is estimated, and the kinds of materials (i.e. radiopharmaceutical).

14. Syringes and unit dosages must be labeled in accordance with 180 NAC 1-007.26 and 004.30, with the radionuclide should be labeled with the radiopharmaceutical, the activity, the date for which the activity is estimated, and the kinds of materials (i.e. radiopharmaceutical). If the container is holding less than the quantities listed in 180 1-004 Appendix C, the syringe or vial need only be labeled as containing radioactive material and the radiopharmaceutical. Label the syringe with the type of study and the patient's name.

15. For prepared dosages, assay each patient dosage in the dose calibrator before administering it. Do not use a dosage if it is more than +/-20 percent off from the prescribed dosage, except for prescribed dosages of less than 30 microcuries or as approved by an authorized user.

16. When measuring the dosage, you need not consider the radioactivity that adheres to the syringe wall or remains in the needle. Check the patient's name and identification number and the prescribed radionuclide, chemical form, and dosage before administering. If the prescribed dosage requires a written directive, the patient's identity must be verified, and the administration must be in accordance with the written directive.

17. Always keep flood sources, syringes, waste, and other radioactive material in shielded containers.

18. Because even sources with small amounts of radioactivity exhibit a high dose rate on contact, you should use a cart or wheelchair to move flood sources, waste, and other radioactive material.

19. Secure all licensed material when not under the constant surveillance and immediate control of the authorized user(s).

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APPENDIX H

MODEL EMERGENCY PROCEDURES

You may use the following model spill procedures as they appear here, saying on your application, "We will establish and implement the model emergency procedures published in Appendix H to Regulatory Guide 7.0."

If you prefer, you may develop your own emergency procedures for review. If you do so, you should consider for inclusion all the items in the model procedures. Say on your application, "We have developed emergency procedures for your review that are appended as Attachment 16," and append your emergency procedures.

MODEL PROCEDURES

Minor Spills of Liquids and Solids

1. Notify persons in the area that a spill has occurred.

2. Prevent the spread of contamination by covering the spill with absorbent paper.

3. Clean up the spill using disposable gloves and absorbent paper. Carefully fold the absorbent paper with the clean side out and place in a plastic bag for transfer to a radioactive waste container. Also put contaminated gloves and any other contaminated disposable material in the bag.

4. Survey the area with a low-range radiation detector survey meter. Check the area around the spill. Also check your hands, clothing, and shoes for contamination.

5. Report the incident to the Radiation Safety Officer (RSO).

6. The RSO will follow up on the cleanup of the spill and will complete the Radioactive Spill Report (see Exhibit 10) and the Radioactive Spill Contamination Survey (see Exhibit 11).

Major Spills of Liquids and Solids

1. Clear the area. Notify all persons not involved in the spill to vacate the room.

2. Prevent the spread of contamination by covering the spill with absorbent paper, but do not attempt to clean it up. To prevent the spread of contamination, limit the movement of all personnel who may be contaminated.

3. Shield the source if possible. This should be done only if it can be done without further contamination or a significant increase in radiation exposure.

4. Close the room and lock or otherwise secure the area to prevent entry.

5. Notify the RSO immediately.

6. Decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water and then washing with a mild soap. If contamination remains, induce perspiration by covering the area with plastic. Then wash the affected area again to remove any contamination that was released by the perspiration.

7. The RSO will supervise the cleanup of the spill and will complete the Radioactive Spill Report (see Exhibit 10) and the Radioactive Spill Contamination Survey (see Exhibit 11).

Major Spills and Minor Spills

The decision to implement a major spill procedure instead of a minor spill procedure depends on many incident-specific variables such as the number of individuals affected, other hazards present, likelihood of spread of contamination, and types of surfaces contaminated as well as the radiotoxicity of the spilled material. For some spills of short-lived radionuclides the best spill procedure may be restricted access pending complete decay.

Use Table H-1, for general guidance to determine whether a major spill procedure or a minor spill procedure should be implemented. Estimate the amount of radioactive materials spilled. Initiate a major or minor spill procedure, based on the following information. Spills above these mCi amounts are considered major, and below are considered minor.

TABLE H-1

RELATIVE HAZARDS OF COMMON RADIONUCLIDES

Radionuclide	Millicuries	Radionuclide	Millicuries	Radionuclide	Millicuries
P-32	1	Se-75	1	I-131	1
Cr-51	100	Sr-85	10	Sm-153	10
Co-57	10	Sr-89	1	Yb-169	10
Co-58	10	Tc-99m	100	Hg-197	10
Fe-59	1	In-111	10	Au-198	10
Co-60	1	I-123	10	Tl-201	100
Ga-67	10	I-125	1		

Spill Kit

You may also want to consider assembling a spill kit that contains:

6 pairs disposable gloves, 1 pair housekeeping gloves
2 disposable lab coats
2 paper hats
2 pairs shoe covers
1 roll absorbent paper with plastic backing
6 plastic trash bags with twist ties
"Radioactive Material" labeling tape
1 china pencil or marking pen
3 prestrung "Radioactive Material" labeling tags
Supplies for 10 contamination wipe samples
Instructions for "Emergency Procedures"
Clipboard with one copy of Radioactive Spill Report Form
Pencil

Forms

You may want to use Exhibit 10, Radioactive Spill Report, and Exhibit 11, Radioactive Spill Contamination Survey Forms.

Emergency Surgery Of Patients Who Have Received Therapeutic Amounts of Radionuclides

If AUs or other personnel involved in the surgical procedure are likely to receive exposures exceeding the nonoccupational permissible dose limits specified in 180 NAC 1-004.14, we will follow the procedures below:

1. If emergency surgery is performed within the first 24 hours following the administration of I-131 sodium iodide, fluids (blood, urine, etc,) will be carefully removed and contained in a closed system.

2. The surgeon and the personnel involved in the surgical procedures will wear protective gear for the protection of the eyes from possible splashing of foreign materials, as well as from beta radiation.

3. The RSO will direct personnel in methods to keep doses ALARA during surgical procedures.

4. If an injury occurs during surgery that results in a cut or tear in the glove used, the individual involved will be monitored to determine if radioactive material was introduced into the wound. The RSO will be informed of any possible radiation hazard.

Autopsy of Patients Who Have Received Therapeutic Amounts of Radionuclides

If AUs or other personnel involved in the autopsy are likely to receive exposures exceeding the nonoccupational permissible exposure limits specified in 180 NAC 1-004.14, we will follow the procedures below:

1. Upon the death of the therapy patient, the AU in charge and the RSO will be notified immediately.

2. An autopsy will be performed only after consultation and permission from the RSO.

3. Protective eye wear will be worn by the pathologist and his assistants for protection from possible splashing of foreign materials and exposure from beta radiation.

4. If an entire block of tissue containing the radionuclide can be removed during autopsy, this will be done first. The remainder of the autopsy can then proceed as usual.

5. The RSO will evaluate the radiation hazard(s), direct personnel in safety and protection, and suggest suitable procedures in order to keep doses ALARA during the autopsy.

6. When possible, separate organs will be promptly removed from the body, and detailed dissection will be carried out a safe distance away from the body.

7. After selected small samples have been removed, the radioactive tissues that are retained will be either promptly placed in shielded vessels for storage or disposed of according to procedures deemed appropriate by the RSO and in accordance with the regulations.

8. If an injury occurs during the autopsy that results in a cut or tear in the glove used, the individual involved will be monitored to determine if radioactive material was introduced into the wound. The RSO will be informed of any possible radiation hazard.

Model Emergency Procedures for Teletherapy Units Containing Sealed Sources-Emergency Procedures for Beam Control Failure or Malfunction

If the light signals or beam-on monitor indicates that the beam control mechanism has failed to terminate the exposure at the end of the pre-set time (If the red light stays on and the green light is off, or if both the red and green lights

stay on for more than a few seconds), the source may still be in an exposed position. The following steps are to be carried out promptly:

1. Open the door to the treatment room.

2. Tell an ambulatory patient to leave the room.

3. If the patient is not ambulatory, enter the treatment room but avoid exposure to the direct beam. Pull the treatment table as far away from the direct beam as possible. Transfer the patient to a stretcher and remove the patient from the room.

4. Close the door and secure the area by locking the door to the treatment room or posting a guard at the entrance.

5. Turn off the main switch at the control panel.

6. Notify the AU and RSO at once.

7. Conspicuously post a sign in the area to warn others of the problem.

AUTHORIZED USER: _____

DUTY PHONE_____ **HOME PHONE** _____

RADIATION SAFETY OFFICER: _____

DUTY PHONE_____ **HOME PHONE** _____

APPENDIX I

MODEL PROCEDURE FOR AREA SURVEYS

You may use the following model procedure to perform area surveys. If you follow the model procedure, you may say on your application, "We will establish and implement the model procedure for area surveys that was published in Appendix I to Regulatory Guide 7.0."

You may develop your own procedure for review. If you do so, you should consider for inclusion all the features in the model procedure. Say on your application, "We have developed survey procedures for your review that are appended as Attachment 17," and append your survey procedures.

MODEL PROCEDURE:

Facilities and Equipment

To ensure achieving the required sensitivity of measurements, survey samples should be analyzed in a low-background area.

Use a gamma counter system with a single or multichannel analyzer to count samples containing gamma-emitters (Cs-137, Co-60).

Use either a liquid scintillation or gas flow proportional counting system to count samples containing alpha-emitters, beta-emitters, and gamma-emitters (if efficiency is great enough to achieve the required sensitivity for measurements).

Ambient Dose Rate Surveys

Dose-rate surveys, at a minimum, will be performed in locations where:

(1) Workers are exposed to radiation levels that might result in radiation doses in excess of 10% of the occupational dose limits, or

(2) An individual is working in an environment with a dose rate of 2.5 mrem/hour or more.

180 NAC 1-004.14 requires that the TEDE to an individual member of the public from the licensed operation does not exceed 1mSv (0.1 rem) in a year, and that the dose in any unrestricted area from external sources does not exceed 0.02mSv (2mrem) in any one hour. Appropriate surveys will be conducted to assure that the requirements of 180 NAC 1-004.14 are met.

Radiation level surveys will consist of measurements with a survey meter sufficiently sensitive to detect 0.1 milliroentgen (mR) per hour. The following areas and frequencies will be followed:

1. Survey at the end of day of use for all radiopharmaceutical elution, preparation, and administration areas (except patient rooms should be surveyed at the end of the therapy

instead of on the day of administration) when using radiopharmaceuticals requiring a written directive (all therapy dosages and I-131 dosage exceeding 30 microcuries).

2. In laboratory areas where only small quantities of gamma-emitting radioactive material are processed (less than 200 microcuries at a time), survey monthly with a radiation detection survey meter.

3. In radiopharmaceutical use, storage and waste storage areas, survey weekly with a radiation detection survey meter. If diagnostic administrations are occasionally made in patient's rooms (such as bone scan injections,Tc-99m heart agents, etc.) and special care is taken to remove all paraphenalia, those rooms need not be surveyed.

4. In sealed source and brachytherapy storage areas, survey quarterly with a radiation measurement survey meter.

5. Immediately notify the RSO if you find unexpectedly high or low levels. The trigger level for notification of the RSO is .05 mR/hr in unrestricted areas and 5.0 mR/hr in restricted areas.

Removable Contamination Surveys

Contamination surveys should be sufficient to identify areas of contamination that might results in doses to workers or to the public. Combined removable and fixed contamination should be surveyed using appropriate radiation detection equipment. Removable contamination can be detected and measured through the use of a wipe test of the surface, counted in an appropriate counting instrument, such as a liquid scintillation counter, a sodium iodide or germanium gamma counter, or a proportional alpha/beta counter.

Contamination surveys should be performed:

- to evaluate radioactive contamination that could be present on surfaces of floors, walls, laboratory furniture, and equipment
- after any spill or contamination event
- when procedures or processes have changed
- to evaluate contamination of users and the immediate work area, at the end of the day, when licensed material is used
- in unrestricted areas at frequencies consistent with the types and quantities of materials in use but not less frequently than monthly
- in areas adjacent to restricted areas and in all areas through which licensed materials are transferred and temporarily stored before shipment

Personnel will survey for contamination in locations where individuals are working with an unsealed form of radioactive material, in an amount greater than or equal to 10% of the smallest annual limit on intake (ALI)(either the inhalation or ingestion ALI) listed for that radionuclide in 180 NAC 1-004. These surveys will be done at a frequency appropriate to the types and quantities of radioactive

materials in use, but at least monthly. If amounts are used that are greater than or equal to the smallest ALI listed for that radionuclide in 180 NAC 1-004, then detailed documented surveys should be performed at least weekly.

The method for performing removable contamination surveys must be sufficiently sensitive to detect the most restrictive isotope used and listed in Table I-1 for restricted areas and Table I-2 for unrestricted areas (e.g., 200 dpm/100cm^2 for isotopes of iodine-131 in unrestricted areas). Removable contamination survey samples should be measured in a low background area. The following area and frequency schedule should be used:

1. Removable contamination surveys weekly for radiopharmaceutical elution, preparation, assay, and administration areas. If diagnostic administrations are occasionally made in patient's rooms (such as bone scan injections,Tc-99m heart agents, etc.) and special care is taken to remove all paraphenalia, those rooms need not be surveyed.

2. In laboratory areas where only small quantities of gamma-emitting radioactive material are processed (less than 200 microcuries at a time), survey monthly with a radiation detection survey meter.

3. Removable contamination surveys weekly for radionuclide storage and radionuclide waste storage areas.

A radioactive source with a known amount of activity will be used to convert sample measurements (usually in cpm) to dpm.

The area will either be decontaminated, shielded, or posted and restricted from use if unable to be decontaminated.

Immediately notify the RSO if you find contamination levels in excess of the trigger levels. Trigger levels for restricted areas are presented in Table I-1. Contamination found in unrestricted areas and on personal clothing will be immediately decontaminated to background levels. When it is not possible to get to background levels, ensure that the amounts do not exceed the contamination levels listed in Table I-2.

Table I-1

Recommended Action Levels in dpm/100 cm^2 for Surface Contamination by Radiopharmaceuticals in Restricted Areas

	P-32, Co-58, Fe-59, Co-60, Se-75, Sr-85, In-111, I-123, I-125, I-131, Yb-169, Au-198,	Cr-51, Co-57, Ga-67, Tc-99m, Hg-197, Tl-201
Restricted areas, protective clothing used only in restricted areas, skin	2,000	20000

Table I-2

Recommended Action Levels in dpm/100 cm^2 for Surface Contamination by Radiopharmaceuticals in Unrestricted Areas

Nuclide[1]	Average[2,3]	Maximum[2,4]	Removable[2,5]
I-125, I-129, Transuranics	100	300	10
I-126, I-131, I-133, Sr-90	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000	15,000	1,000

1 Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for alpha and beta- gamma should apply independently.

2 As used in this table, dpm means the rate of emission by radioactive material, as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation. The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 milirad/hour at 1 cm and 1.0 millirad/hr at 1 cm, respectively, measured through not more than 7 mg/cm^2 of total absorber.

3 Measurements of average contamination should not be averaged over more than one square meter. For objects of less surface area, the average should be derived for each such object.

4 The maximum contamination level applies to an area of not more than 100 cm^2.

5 The amount of removable contamination per 100 cm^2 of surface area should be determined by wiping that area with filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped

When facilities or equipment that are potentially contaminated are to be released to unrestricted areas, Table I-2 provides the maximum acceptable residual levels. To the extent practicable and consistent with the ALARA principle, it is appropriate to decontaminate below these levels. Surface contamination surveys will be conducted for both removable and fixed contamination before transfer to an unrestricted area to ensure these limits are met.

A standardized method for smear testing of a relatively uniform area should be used to aid in comparing contamination at different times and places. A smear taken from an area of about 100 cm^2 is acceptable to indicate levels of removable contamination.

Alternate Survey Frequency

Laboratory classification as to survey frequency is determined from the following conditions and tables. To use the tables, multiply the activity range under LOW, MEDIUM, and HIGH (Table I-4) by the appropriate modifying factors given below as indexed to the radioisotopes in use in the lab.

Modifying factors	Conditions present
X100	Simple storage
X10	Very simple wet operations (preparation of aliquots of stock solutions)
X1	Normal chemical operations (analysis, simple chemical preparations)
X0.1	Complex wet operations (multiple operations or complex apparatus) or simple dry operations (powder manipulations) or work with volatile radioactive compounds.
X0.1	Exposure of non-occupational persons (including patients)
X0.01	Dry and dusty operations (grinding)

Group	Radioisotopes
1	Pb-210, Po-210, Ra-223, Ra-226, Ra-228, Ac-227, Th-227, Th-228, Th-230, Pa-231, U-230, U-232, U-233, U-234, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Am-243, Cm-242, Cm-243, Cm-244, Cm-245, Cm-246, Cf-249, Cf-250, Cf-252
2	Na-22, Cl-36, Ca-45, Sc-46, Mn-54, Co-56, Co-60, Sr-89, Sr-90, Y-91, Zr-95, Ru-106, Ag-110m, Cd-115m, In-114m, Sb-124, Sb-125, Te-127m, Te-129m, I-124, I-126, I-131, I-133, Cs-134, Cs-137, Ba-140, Ce-144, Eu-152(13y), Eu-154, Tb-160, Tm-170, Hf-181, Ta-182, Ir-192, Tl-204, Bi-207, Bi-210, At-211, Pb-212, Ra-224, Ac-228, Pa-230, Th-234, U-236, Bk-249
3	Be-7, C-14, F-18, Na-24, Cl-38, Si-31, P-32, S-35, A-41, K-42, K-43, Ca-47, Sc-47, Sc-48, V-48, Cr-51, Mn-52, Mn-56, Fe-52, Fe-55, Fe-59, Co-57, Co-58, Ni-63, Ni-65, Cu-64, Zn-65, Zn-69m, Ga-72, As-73, As-74, As-76, As-77, Se-75, Br-82, Kr-85m, Kr-87, Rb-86, Sr-85, Sr-91, Y-90, Y-92, Y-93, Zr-97, Nb-93m, Nb-95, Mo-99, Tc-96, Tc-97m, Tc-97, Tc-99, Ru-97, Ru-103, Ru-105, Rh-105, Pd-103, Pd-109, Ag-105, Ag-111, Cd-109, Cd-115, In-115m, Sn-113, Sn-125, Sb-122, Te-125m, Te-127, Te-129, Te-131m, Te-132, I-130, I-132, I-134, I-135, Xe-135, Cs-131, Cs-136, Ba-131, La-140, Ce-141, Ce-143, Pr-142, Pr-143, Nd-147, Nd-149, Pm-147, Pm-149, Sm-151, Sm-153, Eu-152, Eu-155, Gd-153, Gd-159, Dy-165, Dy-166, Ho-166, Er-169, Er-171 (9.2 hr), Tm-171, Yb-175, Lu-177, W-181, W-185, W-187, Re-183, Re-186, Re-188, Os-185, Os-191, Os-193, Ir-190, Ir-194, Pt-191, Pt-193, Pt-197, Au-196, Au-198, Au-199, Hg-197, Hg-197m, Hg-203, Tl-200, Tl-201, Tl-202, Pb-203, Bi-206, Bi-212, Rn-220, Rn-220, Th-231, Pa-233, Np-239

4	H-3, O-15, A-37, Co-58m, Ni-59, Zn-69, Ge-71, Kr-85, Sr-85m, Rb-87, Y-91m, Zr-93, Nb-97, Tc-96m, Tc-99m, Rh-103m, In-113m, I-129, Xe-131m, Xe-133, Cs-134m, Cs-135, Sm-147, Re-187, Os-191m, Pt-193m, Pt-197m, Th-232, Th-Nat, U-235, U-238, U-Nat

Table I-4 Survey Frequency category

Group	Low	Medium	High
1	<0.1 mCi	0.1 mCi to 1 mCi	> 1 mCi
2	<1 mCi	1 mCi to 10 mCi	> 10 mCi
3	<100 mCi	100 mCi to 1 Ci	> 1 Ci
4	<10 Ci	10 Ci to 100 Ci	>100 Ci

Low – Not less than once a month
Medium – Not less than once per week
High - Not less than once per normal working day

Survey Record Requirements

1. Each survey report should include the following:

   a. Diagram of the area surveyed and/or
   b. A list of items and equipment surveyed
   c. Specific locations on the survey diagram where wipe tests were taken
   d. Measured radiation levels with rates in mrem/hr
   e. Removable contamination levels as dpm/100 cm^2
   f. Serial and model number of instruments used
   g. Background levels
   h. Action levels established for each area
   i. Name or initials of the person making the evaluation and recording the results
   j. Date

2. The RSO will review and initial the record at least monthly and also promptly in those cases in which action levels were exceeded.

3. The contamination levels observed and procedures followed should be recorded for incidents involving contamination of individuals. This record should include the names of individuals involved, description of work activities, calculated dose, probable causes (including root causes), steps taken to reduce future incidents of contamination, times and dates and the surveyor's signature.

Exhibit 16 shows a sample record form although it is not part of the model procedure.

APPENDIX J

MODEL PROCEDURE FOR WASTE DISPOSAL

The following general guidance and procedure may be used for disposal of radioactive waste. If you follow all the general guidance and procedures, you may state on your application, "We will establish and implement the general guidance and model procedures for waste disposal that were published in Appendix J to Regulatory Guide 7.0."

If you prefer, you may develop your own procedure for review. If you do so, you should consider for inclusion all the features in the general guidance and models and carefully review the requirements of 180 NAC 1-004.33 to 004.38. Say on your application, "We have developed a procedure for waste disposal for your review that is appended as Attachment 18," and attach your procedure.

Overview

There are four commonly used methods of waste disposal: release to the environment through effluents (sanitary sewer or evaporative release); decay-in-storage (DIS); transfer to a burial site or back to the manufacturer; and release to in-house waste. With the exception of the patient excreta (See 180 NAC 1-004.35B) and generally licensed in vitro kit exemptions (See 180 NAC 1-003.07I6), nothing in these guidelines relieves the licensee from maintaining records of the disposal of radioactive material (See 180 NAC 1-003.29A and 004.48.)

General Guidance

1. All radioactivity labels must be defaced or removed from containers and packages prior to disposal as in-house waste. If waste is compacted, all labels that are visible in the compacted mass must be defaced or removed.

2. Remind employees that nonradioactive waste such as leftover reagents, boxes, and packing material should not be mixed with radioactive waste.

3, Occasionally monitor all procedures to ensure that radioactive waste is not created unnecessarily. Review all new procedures to ensure that waste is handled in a manner consistent with established procedures.

4. In all cases, consider the entire impact of various available disposal routes. Consider occupational and public exposure to radiation, other hazards associated with the material and routes of disposal (e.g., toxicity, carcinogenicity, pathogenicity, flammability), and expense.

MODEL PROCEDURE FOR DISPOSAL OF LIQUIDS AND GASES

Liquids may be disposed of by release to the sanitary sewer or evaporative release to the atmosphere. This does not relieve licensees from complying with other regulations regarding toxic or hazardous properties of these materials.

1. Regulations for disposal in the sanitary sewer appear in 180 NAC 1-004.35. Material must be readily soluble or dispersible in the water. There are daily and monthly limits based on the total sanitary sewerage release of your facility. (Excreta from patients undergoing medical diagnosis or therapy is exempt from all the above limitations; See 180 NAC 1-004.35B.) Make a record of the date, radionuclide, estimated activity that was released (in millicuries or microcuries), and of the sink or toilet at which the material was released.

2. Limits on permissible concentrations in effluents to unrestricted areas are enumerated in Table II of Appendix B to 180 NAC 1-004. These limits apply at the boundary of the restricted area. Make a record of the date, radionuclide, estimated activity that was released (in millicuries or microcuries) and estimated concentration, and of the vent site at which the material was released.

3. Liquid scintillation-counting media containing 0.05 microcurie per gram of H-3, C-14 or I-125, may be disposed of without regard to its radioactivity (See 180 NAC 1-004.37). Make a record of the date, radionuclide, estimated activity (in millicuries or microcuries), calculated concentration in microcuries per gram, and how the material was disposed of.

MODEL PROCEDURE FOR DISPOSAL BY DECAY-IN-STORAGE (DIS)

Title 180 NAC 1-007.33 describes the requirements for DIS. Short term storage should be designed to allow for segregation of wastes with different half-lives (use multiple shielded containers). Containers should have shielded covers to maintain occupational exposure at ALARA levels. The storage area must be in a secure location.

1. Consider using separate containers for different types of waste, e.g., capped needles and syringes in one container, other injection paraphernalia such as swabs and gauze in another, and unused dosages in a third container. Because the waste will be surveyed with all shielding removed, the containers in which waste will be disposed of must not provide any radiation shielding for the material.

2. When the container is full, seal it with string or tape and attach an identification tag that includes the date sealed, the longest-lived radioisotope in the container, and the initials of the person sealing the container. The container may then be transferred to the DIS area.

3. Decay the material for at least 10 half-lives.

4. Prior to the disposal as in-house waste, monitor and record the monitoring of each container as follows:

a. Choose a survey instrument that is appropriate for the type of and energy of the radiation being measured.

b. Check your radiation detection survey meter for proper operation;

c. Plan to monitor in a low-level (less than 0.05 millirem per hour) area away from all sources of radioactive material if possible.

d. Remove any shielding from around the container or generator column;

e. Monitor, at contact, all surfaces of each individual container;

f. Remove or deface any radioactive material labels (unless the containers will be immediately incinerated and instruction has been provided to the incinerator operator regarding radioactive labels and potential hazards)

g. Discard as in-house waste only those containers that cannot be distinguished from background. Record the disposal date, the radionuclides disposed, survey instrument used, background dose rate, dose rate measured at the surface of each container and the name of the individual who performed the task.

h. Containers that can be distinguished from background radiation levels must be returned to the storage area for further decay or transferred to an authorized byproduct material recipient.

MODEL PROCEDURE FOR RETURNING GENERATORS TO THE MANUFACTURER

Used Mo-99/Tc-99m generators may be returned to the manufacturer. This permission does not relieve licensees from the requirement to comply with 180 NAC 1-013 and Department of Transportation (DOT) regulations.

1. Retain the records needed to demonstrate that the package qualifies as a DOT Specification 7A container. (See DOT regulations, paragraph 173.415(a) of 49 CFR Part 173).

2. Assemble the package in accordance with the manufacturer's instructions.

3. Perform the dose rate and removable contamination measurements required by paragraph 173.475(i) of 49 CFR Part 173.

4. Label the package and complete the shipping papers in accordance with the manufacturer's instructions.

5. Retain records of receipts and transfers in accordance with Title 180 NAC 1-003.29.

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MODEL PROCEDURE FOR RETURNING LICENSED MATERIAL TO AUTHORIZED RECIPIENTS

When returning licensed material to authorized recipients:

1. In accordance with 180 NAC 1-003.24B4, confirm that persons are authorized to receive radioactive material prior to transfer (obtain a copy of the transferee's NRC or Agreement State license that authorizes such receipt).

2. Retain the records needed to demonstrate that the package qualifies as a DOT Specification 7A container. (See DOT regulations, paragraph 173.415(a) of 49 CFR Part 173).

3. Assemble the package in accordance with the manufacturer's instructions.

4. Perform the dose rate and removable contamination measurements required by paragraph 173.475(i) of 49 CFR Part 173.

5. Label the package and complete the shipping papers in accordance with the manufacturer's instructions.

6. Retain records of receipts and transfers in accordance with Title 180 NAC 1-003.29.

MODEL PROCEDURE FOR TRANSFER FOR BURIAL

Except for material suitable for DIS and some animal carcasses, solids must be transferred to a land disposal site. Follow the packaging instructions you received from the transfer agent and the land disposal site operator. For your record of disposal, keep the consignment sheet that the transfer agent gave you.

MODEL PROCEDURE FOR RELEASE TO IN-HOUSE WASTE

Waste from in vitro kits that are generally licensed pursuant to 180 NAC 1-003.07I is exempt from waste disposal regulations. Radioactive labels should be defaced or removed. There is no need to keep any record of release or make any measurement.

APPENDIX K

MODEL PROCEDURE FOR RADIATION SAFETY DURING IODINE THERAPY REQUIRING PATIENT HOSPITALIZATION

You may use the following procedure for reducing worker and public dose during radiopharmaceutical therapy. If you will follow the model procedure, you may say on your application, "We will establish and implement the model procedure for radiation safety during radiopharmaceutical therapy that was published in Appendix K to Regulatory Guide 7.0."

If you prefer, you may develop your own procedure for review. If you do so, you should consider for inclusion all the features in the model procedure and carefully review the requirements of 180 NAC 1-010.03, 004.14 and 004.15. Say on your application, "We have developed a procedure for radiation safety during therapeutic use of radiopharmaceuticals for your review that is appended as Attachment 19," and append your procedure.

MODEL PROCEDURE

1. The patient's room will be as far away from the nursing station and heavy traffic hallways as is consistent with good medical care. It will be a private room with private sanitary facilities and should be without carpet.

2. Prepare the room for the procedure as follows:

   a. Use leak-proof absorbent paper to cover large surfaces (the bed, chairs, and the floor around the toilet) that are likely to be contaminated. Small items (telephone, door knobs, bed remote control, television control, and nurse call cord) may be covered with absorbent paper or plastic bags.

   b. Prepare separate boxes for linen, disposable waste, and nondisposable contaminated items. Place a single large reclosable plastic bag in each box, or supply several small plastic bags.

   c. Determine whether urine will be discarded by release to the sanitary sewer or collected. If urine will be collected, prepare collection containers.

      (1) Containers should be unbreakable and closable.

      (2) If there is no need for assay or volumetric determination and urine will be decayed in storage, add to each container an absorbent such as vermiculite.

      (3) To avoid room contamination in the case of a spill, place containers in a box or deep tray that has been lined with a plastic bag and absorbent paper or vermiculite.

(4) Supply a few half-value layers of shielding for each container. (For I-131, one half-value layer is approximately 3 mm of lead.)

(5) Supply a wide-mouth antisplash funnel.

d. Stock additional disposable gloves, absorbent paper, and radioactive waste labels in the room for use as necessary by nursing, nuclear medicine, and radiation safety personnel.

3. Order disposable table service for the duration of the patient's stay. Inform the Housekeeping Office that personnel should stay out of the room until otherwise notified.

4. Supply the nurses with film badges, TLDs, or pocket ionization chambers.

5. Brief the nurses on radiation safety precautions. Use the sample form, "Nursing Instructions for Patients Treated with Iodine-131, Phosphorus-32, or Gold-198" (Exhibit 17), or your own nursing instruction form as an outline. Allow time for questions and answers during the briefing. Leave a written copy of the radiation safety precautions in the patient's chart or at the nurses' station.

6. Brief the patient on radiation safety procedures for the dosage administration, visitor control, urine collection, radioactive waste, and other items as applicable.

7. Only those persons needed for medical, safety, or training purposes should be present during the administration.

8. Mark a visitors' "safe line" on the floor with tape as far from the patient as possible.

9. Following administration of the dosage, measure the exposure rate in mR/hr at bedside, at 1 meter from bedside, at the visitors' "safe line," and in the surrounding hallways and rooms (the last rates must conform to requirements in 180 NAC 1-004.14A). Record this and any other necessary information on the nursing instructions form or the nurses' dosimeter sign-out form. Post the room with a "Radioactive Materials" sign.

10. For patients treated with liquid or gelatin-capsuled I-131, 1 day after the dosage administration, measure the thyroid burden of all personnel who were present for the administration or helped prepare the dose. Also consider a thyroid burden assay for patient care personnel 2 days after the administration. Make a record of the worker's name, amount of I-131 activity in a thyroid phantom in microcuries and associated counts per minute, the counts per minute from the worker's thyroid, the calculated thyroid burden, and date.

11. As the therapy proceeds, pick up waste for transfer to a decay-in-storage or decontamination area.

12. Do not release any patient until the total effective dose equivalent (TEDE) to any other individual exposed to the patient will not be likely to exceed 500 millirem. Acceptable means to make this determination are covered in Nebraska Reg Guide 7.1.

13. Before using the room for general occupancy, it must be decontaminated and released to the Admitting Office.

    a. Remove all absorbent paper, and place it in the appropriate container.

    b. Transfer all containers to a decay-in-storage or decontamination area.

    c. Use a radiation detection survey meter to check for room contamination. Clean contaminated areas until removable contamination is less than 200 dpm/100cm^2.

    d. Call the Housekeeping Office to remove the cleaning restriction and call the Admitting Office to return the room to the vacant list.

Exhibit 18, "Radiation Safety Checklist for Iodine Therapy Requiring Patient Hospitalization," may also be helpful to you.

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APPENDIX L

MODEL PROCEDURE FOR RADIATION SAFETY DURING IMPLANT THERAPY

You may use the following procedure to reduce worker and public dose during implant therapy. If you will follow the model procedure, you may say on your application, "We will establish and implement the model procedure for radiation safety during implant therapy that was published in Appendix L to Regulatory Guide 7.0."

If you prefer, you may develop your own procedure for review. If you do so, you should consider for inclusion all the features in the model procedure and carefully review the requirements of 180 NAC 1-010.03, 004.14 and 004.15. Say on your application, "We have developed a procedure for radiation safety during implant therapy for your review that is appended as Attachment 20," and append your procedure.

You may find a checklist to be helpful, such as Exhibit 19, "Radiation Safety Checklist for Temporary Implant Therapy."

MODEL PROCEDURE

1. The patient's room will be as far away from the nursing station and heavy traffic hallways as is consistent with good medical care. It will be a private room unless the dose at one meter from the implant meets the requirements in 180 NAC 1-004.14A.

2. Supply the nurses with film badges, TLDs, or pocket ionization chambers.

3. Brief the nurses on radiation safety precautions. Use the sample form, "Nursing Instructions For Patients Treated with Temporary Implant Sources," Exhibit 20, or your own nursing instruction form as an outline. Allow time for questions and answers during the briefing.

4. Brief the patient on radiation safety procedures for confinement to bed, visitor control, and other items as applicable consistent with good medical care.

5. Only those persons needed for medical, safety, or training purposes should be present during the implant procedure.

6. Mark a visitors' "safe line" on the floor with tape as far from the patient as possible.

7. Following the implant, measure the exposure rate in mR/hr at bedside, at 1 meter from bedside, at the visitors' "safe line," and in the surrounding hallways and rooms (the last rates must conform to requirements in 180 NAC 1-004.14A). Record this and any other necessary information on the nursing instruction form or the nurses' dosimeter sign-out form. Post the room with a "Caution, Radioactive Materials" sign.

8. Do not release any patient who has received a temporary implant from the hospital until both a radiation survey of the patient and a count of implant sources, trains, or ribbons confirms that all sources have been removed from the patient and are accounted for. Perform this check immediately after the removal of the sources. Keep a record confirming the source count and radiation survey on the implant source running inventory form. For low-activity seeds (less than 1 millicurie), use an individual seed to check the survey meter to be sure it will easily detect a seed that has not been removed or has been lost.

9. Do not release any patient who has received a permanent implant from the hospital until the total effective dose equivalent (TEDE) to any other individual exposed to the patient will not be likely to exceed 500 millirem. Acceptable means to make this determination are covered in Nebraska Reg Guide 7.1.

You may want to use the sample forms in Exhibit 19, "Radiation Safety Checklist for Temporary Implant Therapy," Exhibit 20, "Nursing Instructions for Patients Treated with Temporary Implant Sources," and Exhibit 21, "Sample Cesium Implant Source Log."

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APPENDIX M

MODEL PROCEDURE FOR MONITORING, CALCULATING, AND CONTROLLING AIR CONCENTRATIONS

WORKER DOSE FROM NOBLE GASES

Noble gases such as xenon in the air present an external source of radiation exposure that must be calculated. Many commercially available dosimeters and survey instruments are not capable of accurately measuring worker doses from immersion in noble gases.

If you will collect spent gas in a shielded trap with an effluent air contamination monitor and will follow the monitor manufacturer's instructions for checking its accuracy and constancy, you may respond to Item 21 by saying, "We will collect spent noble gas in a shielded trap and monitor the trap effluent with an air contamination monitor that we will check regularly according to the manufacturer's instructions."

If you will collect spent gas in a shielded trap and will follow the model procedure for checking trap effluent, you may respond to Item 21 by saying, "We will collect spent noble gas in a shielded container and will establish and implement the model procedure for checking trap effluent that was published in Appendix M.3 to Regulatory Guide 7.0."

If you are not monitoring trap effluent or if you exhaust spent gas to the atmosphere, you must estimate worker dose by calculation. If you will follow the model procedure below for calculating worker dose from noble gases, you may respond to Item 21 by saying, "We will follow the model procedure for calculating worker dose from noble gases that was published in Appendix M.1 to Regulatory Guide 7.0."

If none of the above apply, you may develop your own procedure for review. If you do so, you should consider all the above information and carefully review the requirements of 180 NAC 1-004.07, 004.08, 004.09, 004.17, 007.32, and 007.38. Say on your application, "We have developed a procedure for monitoring worker dose due to submersion in noble gases that is appended as Attachment 21," and append your procedure for monitoring worker dose from noble gases.

WORKER DOSE FROM AEROSOLS

If you will collect spent aerosol in a shielded trap, will use an air contamination monitor for reusable traps, and will follow the monitor manufacturer's instructions for checking for accuracy and constancy, you may respond to Item 21 by saying, "We will collect spent aerosol in a shielded trap and, for reusable traps, monitor the trap effluent with an air contamination monitor that we will check regularly according to the manufacturer's instructions." You do not have to monitor the trap effluent of single-use devices.

If you are not monitoring reusable trap effluent or if you are exhausting spent aerosol to the atmosphere, you must estimate worker dose by calculation. (You do not have to submit the calculations, but you should keep them for Agency review during inspections.) If you will follow the model procedure below for calculating worker dose from aerosols, you may respond to Item 21 by saying, "We will follow the model procedure for calculating worker dose from aerosols that was published in Appendix M.1 to Regulatory Guide 7.0."

If neither of the above apply, you may develop your own procedure for review. If you do so, you should consider all the above information and carefully review the requirements of 180 NAC 1-004.07, 004.08, 004.09, 004.14, 004.15, 004.17, and 007.32. Say on your application, "We have developed a procedure for monitoring worker dose due to aerosol concentrations that is appended as Attachment M.2," and append your procedure for monitoring worker dose from aerosols.

M.1 MODEL PROCEDURE FOR CALCULATING WORKER DOSE FROM CONCENTRATIONS OF GASES AND AEROSOLS IN WORK AREAS

1. Collect the following data:

   a. Estimated number of studies per week;

   b. Activity to be administered per study;

   c. Estimated activity lost to the work areas per study (you may assume 20 percent loss);

   d. Measured airflow supplied by each vent in the imaging room (if different during heating and cooling seasons, use the lesser value);

   e. Measured airflow exhausted by each vent in the imaging room (the exhaust should be vented and not recirculated within the facility);

   f. Measured airflow exhaust at the storage site (e.g., a fume hood); and

   g. Maximum permissible air concentrations in restricted and unrestricted areas. For Xe-133, the maximum permissible values are 1×10^{-4} uCi/ml in restricted areas and 5×10^{-7} uCi/ml in unrestricted areas. For soluble Tc-99m, the maximum permissible values are 6×10^{-5} uCi/ml in restricted areas and 2×10^{-7} uCi/ml in unrestricted areas. For other gases or aerosols, see Appendix B to 180 NAC 1-004.

2. The following calculations must be made:

   a. The sum of all measured exhaust rates and the sum of all measured supply rates. If the former is larger than the latter, this ensures that the imaging room is at negative pressure.

   b. The estimated average concentration in restricted areas.

(1) The total activity released to the restricted area (activity used each week multiplied by estimated fractional loss per study) divided by the total air exhausted (sum of all exhaust rates multiplied by the length of the work week) must be less than the applicable maximum permissible value for a restricted area.

(2) If this is not the case, plan for fewer studies. (An increase in the ventilation rate will not significantly reduce the downwind effluent concentration because it is primarily a function of the natural dispersion in the atmosphere.)

M.2 MODEL PROCEDURE FOR CALCULATING AIRBORNE EFFLUENT CONCENTRATION

1. Divide the total activity released to an unrestricted area (activity used each week that is released in an exhaust system) by the total volume of air exhausted over the week ("on" time multiplied by measured airflow rate). The quotient must be less than the applicable maximum permissible value for an unrestricted area.

2. If this is not the case, plan for fewer studies and do the calculation again. Alternatively, you may consider collection and decay-in-storage for waste, or restriction of access to the release point and calculation of concentration at the boundary of the restricted area.

M.3 MODEL PROCEDURE FOR MONITORING OR CHECKING TRAP EFFLUENT

Charcoal traps can significantly reduce air contamination. They can also become saturated or be spoiled by improper use, humidity, chemicals, or inadequate maintenance.

1. If the trap effluent is monitored by a radiation detector designed to monitor effluent gas, check the detector according to the manufacturer's instructions and keep a record of the checks.

2. If you do not monitor the trap effluent, check it on receipt and once each month. Collect the effluent from the trap during/after one patient study in a plastic bag and then monitor the activity in the bag by holding the bag against a camera, with the camera adjusted to detect the noble gas, and compare its counts per minute (cpm) to background cpm with no other radioactivity in the area. Keep a record of the date, background cpm, and bag cpm.

3. The RSO will establish an action level based on cpm or a multiple of background cpm. If you measure a significant increase in the bag cpm, the trap is breaking down and must be replaced.

4. Follow the trap manufacturer's instructions for replacing the trap.

PUBLIC DOSE FROM AIRBORNE EFFLUENT

Effluent release presents a potential source of dose to the public. Usually a calculation of concentration at the release point is done and compared to the appropriate value of Table II of Appendix B to 180 NAC 1-004.

If you are not directly venting aerosols and gases to the atmosphere, you may respond to Item 21 by saying, "We will not directly vent spent aerosols and gases to the atmosphere and therefore no effluent estimation is necessary."

If you are going to vent aerosols or gases to the atmosphere, you must estimate effluent concentrations by calculation. (You do not have to submit the calculations with your application, but you should keep them for Agency review during inspections.) If you will follow the model procedure below for calculating release concentrations, you may respond to Item 21 by saying, "We will follow the model procedure for calculating airborne effluent concentration that was published in Appendix M.2 to Regulatory Guide 7.0."

If neither of the above apply, you may develop your own procedure for review. If you do so, you should consider all the above information and carefully review the requirements of 180 NAC 1-004.07, 004.08, 004.09, 004.14, 004.15, 004.17, 007.32 and 007.38. Say on your application, "We have developed a procedure for monitoring airborne effluent concentration that is appended as Attachment 21," and append your procedure for monitoring airborne effluent concentration.

SPILLED GAS CLEARANCE TIME

Because normal room ventilation is usually not sufficient to ensure timely clearance of spilled gas, the calculations described in Appendix M.4 should be done to determine for how long a room should be cleared in case of a gas spill. This clearance time should be posted in the room.

If you will calculate spilled gas clearance times according to the following procedure, you may respond to Item 21 by saying, "We will calculate spilled gas clearance times according to the procedure that was published in Appendix M.4 to Regulatory Guide 7.0."

You may develop your own procedure for review. If you do so, you should consider all the above information and carefully review the requirements of 180 NAC 1-007.38. Say on your application, "We have developed a procedure for calculating spilled gas clearance times that is appended as Attachment 21," and append your procedure.

M.4 MODEL PROCEDURE FOR CALCULATING SPILLED GAS CLEARANCE TIME

1. Collect the following data:

    a. A, the highest activity of gas in a single container, in microcuries;

b. Measured airflow supply from each vent in the room (if different during heating and cooling seasons, use the lesser value), in milliliters per minute;

c. Q, the total room air exhaust determined by measuring, in milliliters per minute, the airflow to each exhaust vent in the room (the exhaust should be vented and not recirculated within the facility); this may be either the normal air exhaust or a specially installed gas exhaust system.

d. C, the maximum permissible air concentrations in restricted and unrestricted areas. For Xe-133, the maximum permissible values are 1×10^{-4} uCi/ml in restricted areas and 5×10^{-7} uCi/ml in unrestricted areas. For other gases, see Appendix 1 to 180 NAC 1-004; and

e. V, the volume of the room in milliliters.

2. For each room make the following calculations:

a. The airflow supply should be less than the airflow exhaust to ensure the room is at negative pressure.

b. The evacuation time $t = -(V/Q) \times \ln(C \times V/A)$

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APPENDIX O

MODEL PROCEDURE FOR LEAK-TESTING SEALED SOURCES

You or your contractor may use the following model procedure to leak-test sealed sources. If you, or the contractor, follow the model procedure you may say on your application, "We will establish and implement the model procedure for leak-testing sealed sources that was published in Appendix O to Regulatory Guide 7.0."

You may develop your own procedure for review. If you do so, you should consider for inclusion all the features in the model and carefully review the requirements of 180 NAC 1-007.24. Say on your application, "We have developed a leak-test procedure for your review that is appended at Attachment 23," and append your leak-test procedure.

FACILITIES AND EQUIPMENT

1. To ensure achieving the required sensitivity of measurements, leak tests should be analyzed in a low-background area.

2. Consider using a NaI(Tl) well counter system with a single or multichannel analyzer to analyze samples obtained from gamma-emitting sources (such as Cs-137)

3. Consider using a liquid scintillation or gas-flow proportional counting system to analyze samples obtained from beta-emitting sources (such as Sr-90).

4. Instrumentation used to analyze leak test samples must be capable of detecting 0.005 microcuries of radioactivity.

MODEL PROCEDURE

1. Make a list of all sources to be tested. This should include at least the isotope, the activity on a specified date, and the sealed source serial number.

2. If you will be testing sources stronger than a few millicuries, set out a survey meter, preferably with a speaker, so you can monitor your exposure rate.

3. Prepare a separate wipe sample for each source. A cotton swab, injection prep pad, filter paper, or tissue paper is suitable. Number each wipe so you will know for which source it is to be used. Samples should be taken as follows while wearing gloves:

   a. For small sealed sources, it may be easier to wipe the entire accessible surface area. Pay particular attention to seams and joints. However, do not wipe the port of beta applicators.

b. For larger sealed sources and devices (survey meter calibrator, bone mineral analyzer source), take the wipe near the radiation port and on the activating mechanism.

c. For teletherapy machines, take the wipe with the source in the off position. Wipe the area near the shutter mechanism, taking care to touch neither field light and mirror nor crosshairs. Also wipe the primary and secondary collimators and trimmers.

d. If you are testing radium sources at the same time you are testing other licensed sources, they should also be checked for radon leakage. This can be done by submerging the source in a vial of fine-grained charcoal or cotton for a day. Then remove the source and analyze the adsorbent sample as described below. A survey should be done to be sure the sources are adequately shielded during the leak-test period.

4. The samples will be analyzed as follows:

a. Select an instrument that is sufficiently sensitive to detect 0.005 microcurie. For beta sources, a proportional flow counter, liquid scintillation counter, or thin-end-window GM survey meter may be appropriate. For gamma sources, a crystal with a ratemeter or scaler or a GM-survey meter may be appropriate. Dose calibrators used in nuclear medicine are not sufficiently sensitive. Measure the background count rate and record.

b. To estimate the detection efficiency of the analyzer used to assay the wipe samples, assay a check source that has the same isotope as the sealed source and whose activity is certified by the supplier. Accuracy of such sources should be within 5% of the stated value and traceable to a primary radiation standard such as those maintained by NIST. If one is not available, it will be necessary to use a certified check source with a different isotope that has a similar spectrum. If calculations demonstrate that the instrument is not sufficiently sensitive to detect 0.005 microcurie, a different instrument must be used.

c. Calculate the efficiency of the instrument:

For example; [(cpm from the std) – (cpm from bckgrd)]/(activity of std in microcuries)
= efficiency in cpm/microcurie

d. Assay the wipe sample. It must be in the same geometry relative to the detector as was the certified check source.

e. Record the wipe sample's net counts per minute. Then calculate and record the estimated activity in microcuries on the wipe sample. This is calculated by taking the net (cpm from wipe sample-cpm from background) cpm for the sample and dividing it by the efficiency in cpm/microcurie of the instrument.

f. Continue the same analysis procedure for all wipe samples.

5. Leak test records will be retained in accordance with 180NAC1-007.24D for five years. The records must contain:

   a. Model number and serial number (if assigned) of each source tested

   b. Identity of each source radionuclide and its estimated activity

   c. Measured activity of each test sample expressed in microcuries

   d. Description of the method used to measure each test sample

   e. Test date

   f. Individuals name who performed the test

6. If the wipe sample activity is 0.005 microcurie or greater, notify the RSO. The source must be immediately withdrawn from use to be repaired or disposed of. If it is a source distributed under an Agency, NRC or Agreement State license, the Agency must be notified. (See 180 NAC 1-007.24E2).